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(54) **DEVICE FOR CONDUCTING SOURCE LIGHT THROUGH AN ELECTROMAGNETIC COMPLIANT FACEPLATE**

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(52) **U.S. Cl.** **362/551**; 362/489; 362/555; 362/581
(58) **Field of Search** 362/551, 554, 362/555, 556, 581, 489

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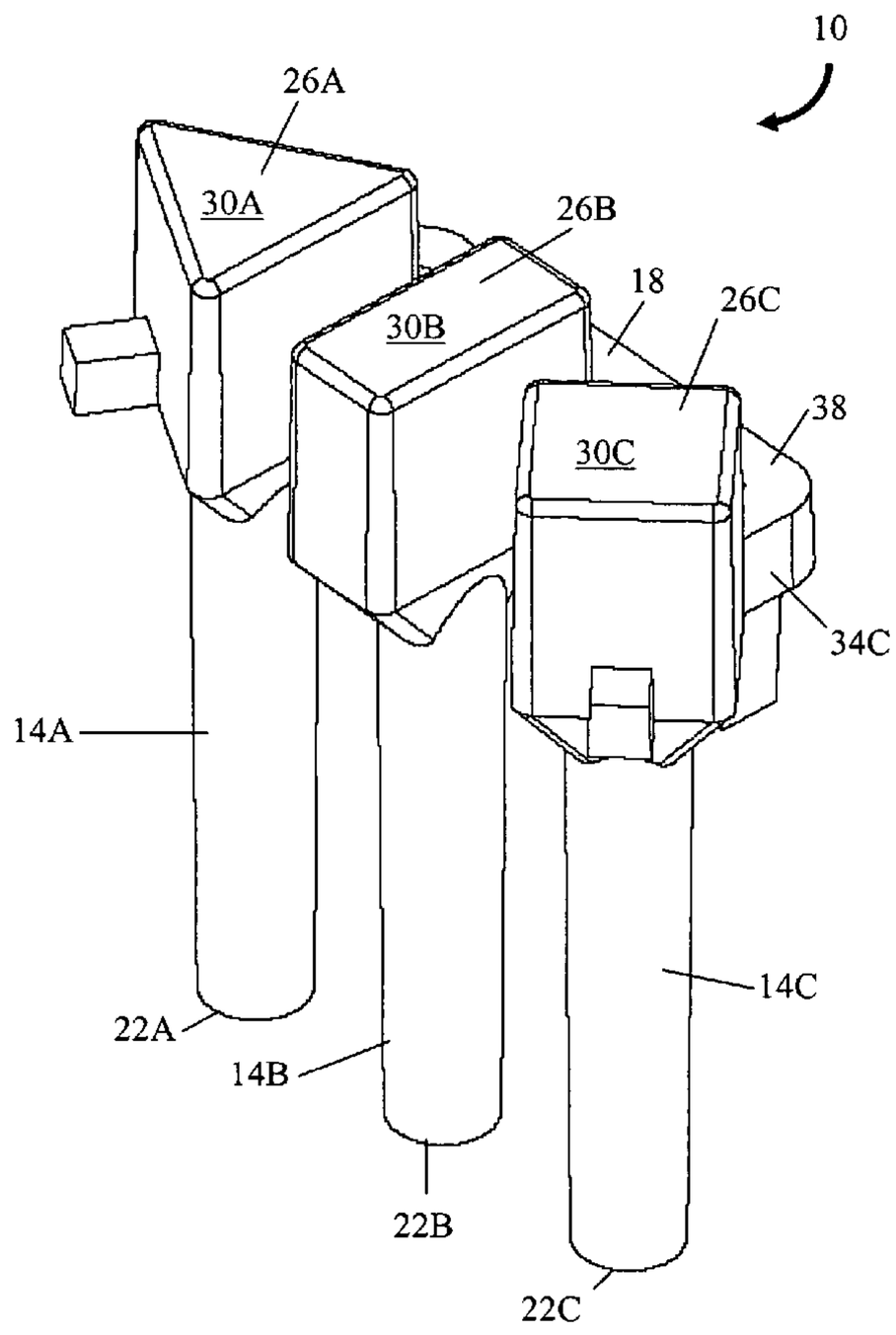
(57) **ABSTRACT**

A device for conducting light through an electromagnetic compliant faceplate is described. The device includes a first light pipe, a second light pipe, and a connector. The first light pipe has a first end to receive light from a first light source and a second end with an expanded endface. The second light pipe has a first end to receive light from a second light source and a second end with an expanded endface. The connector is attached to the first and second light pipes and has an elongated portion, a first attachment portion and a second attachment portion. The first and second attachment portions extend from the elongated portion and are coupled to the first and second light pipes.

12 Claims, 5 Drawing Sheets



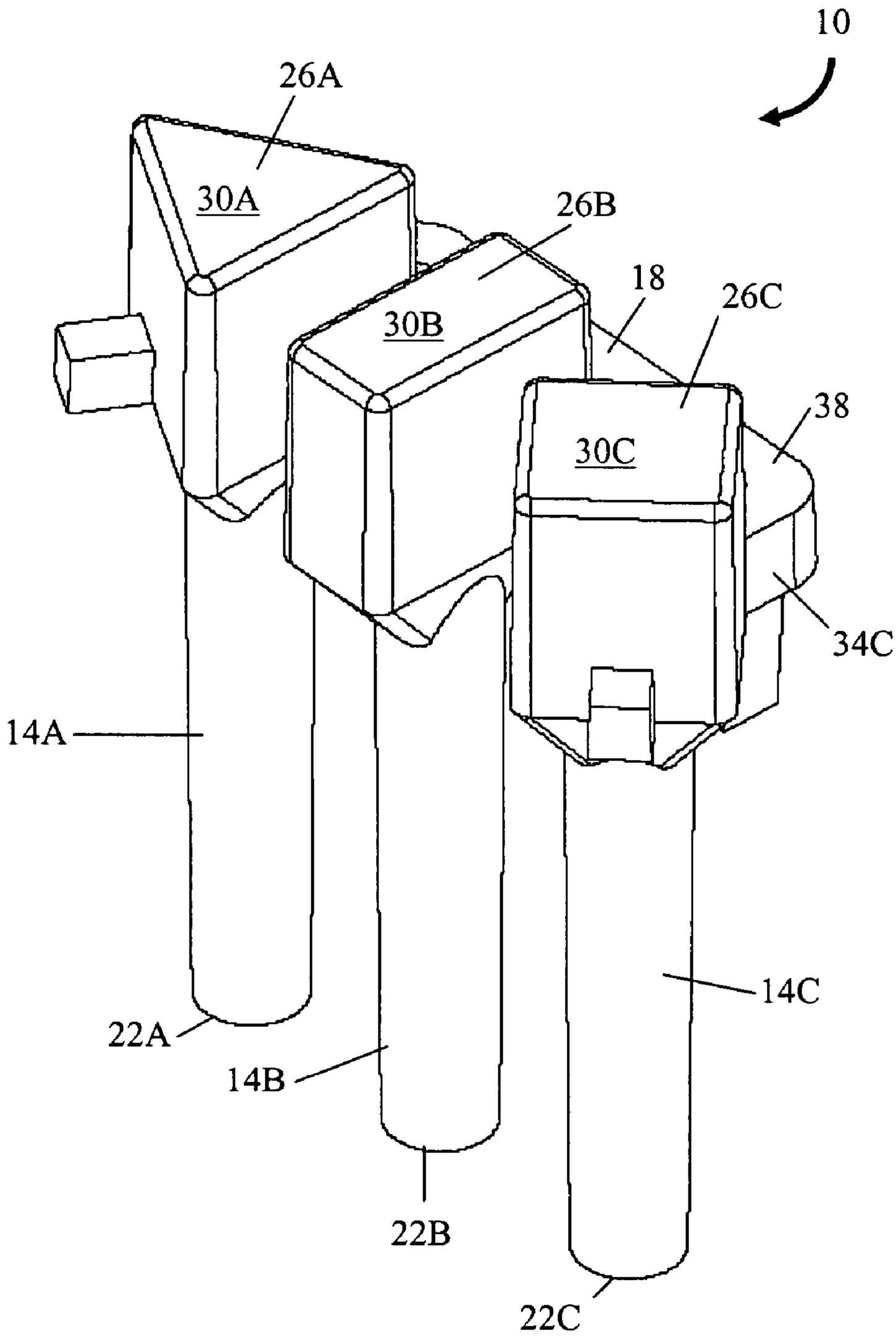


FIG. 1A

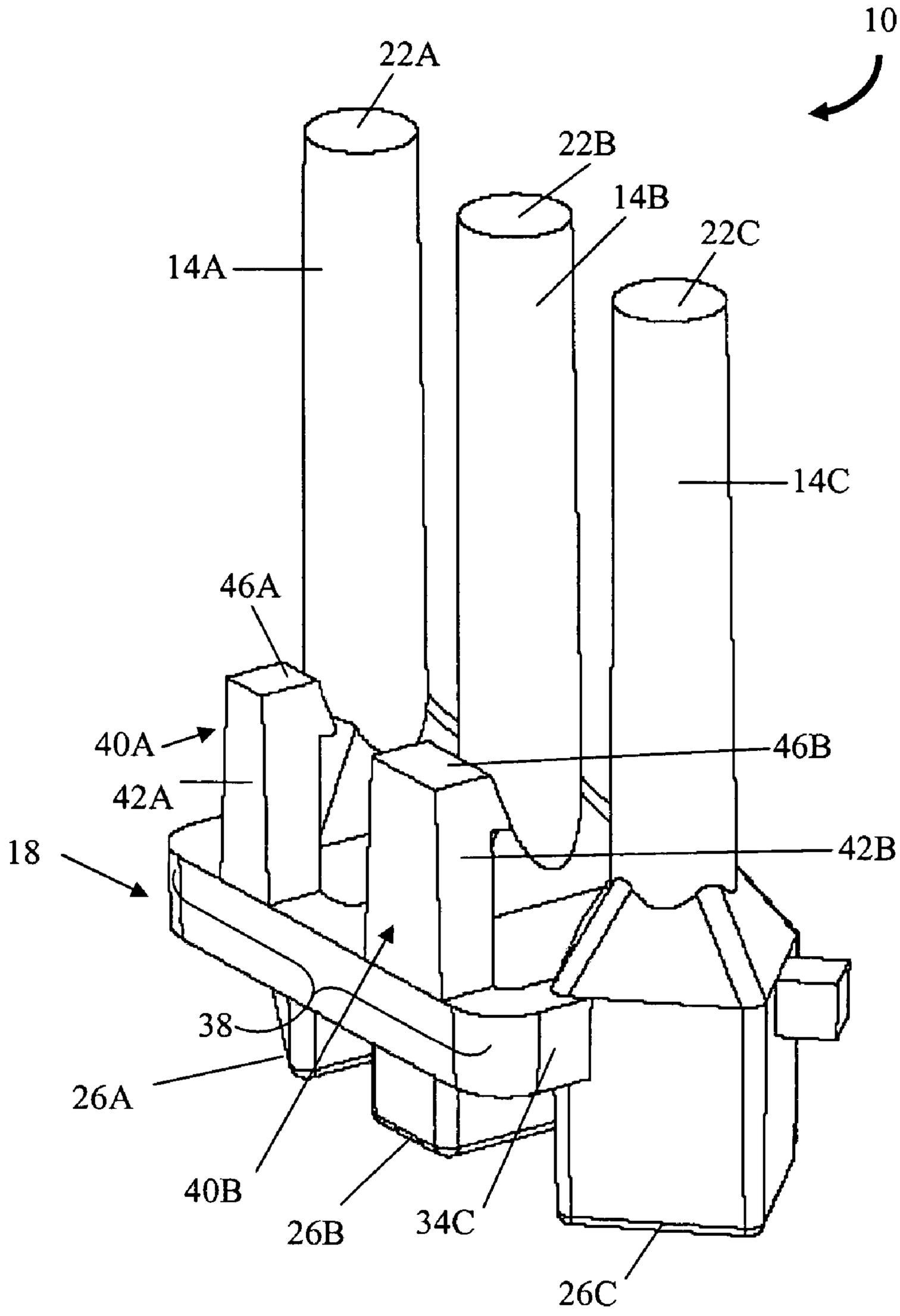

10
22A
22B
14B
22C
14A
14C
46A
40A
46B
42A
42B
18
38
26A
40B
26B
34C
26C

FIG. 1B

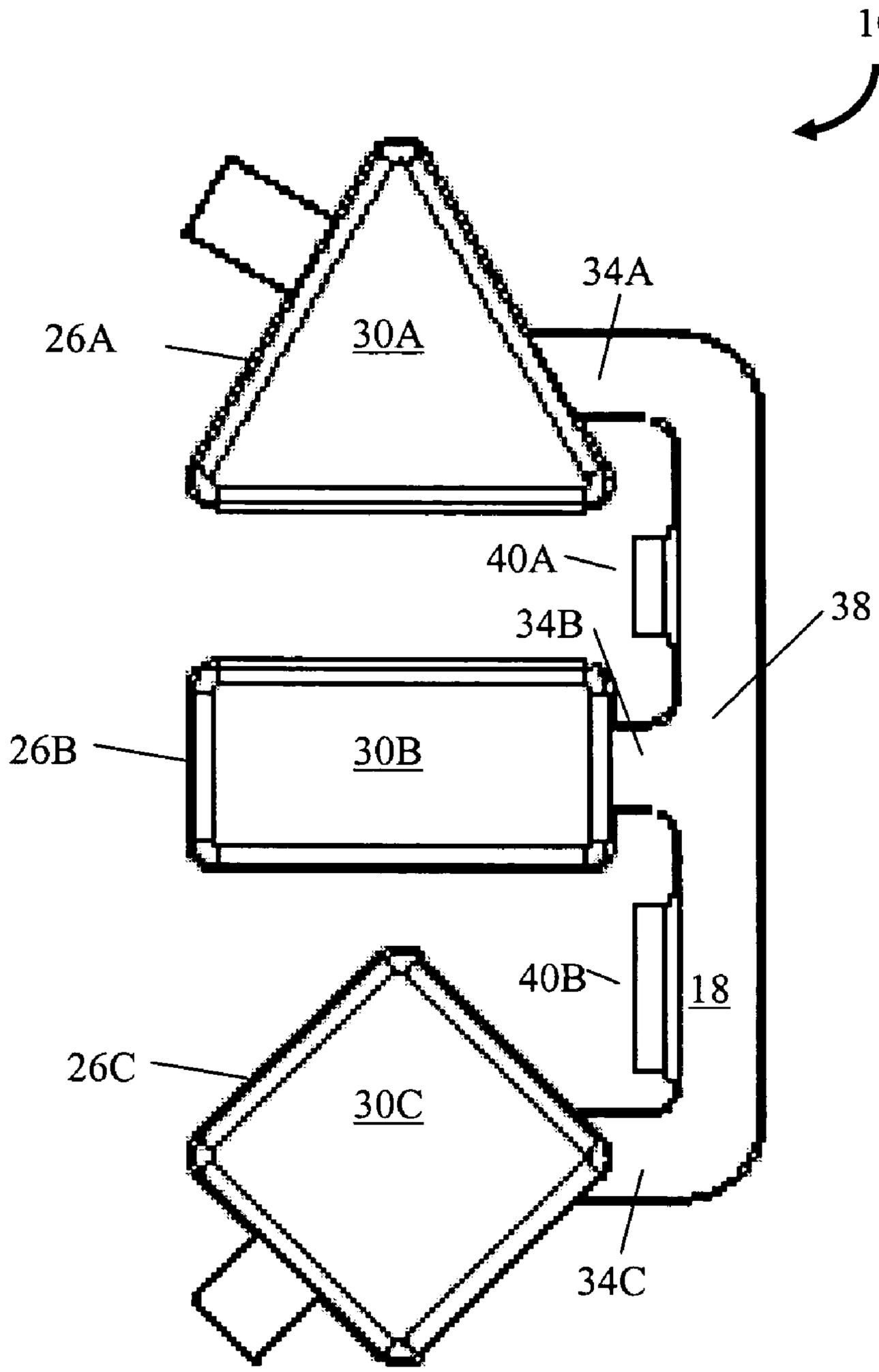


FIG. 1C

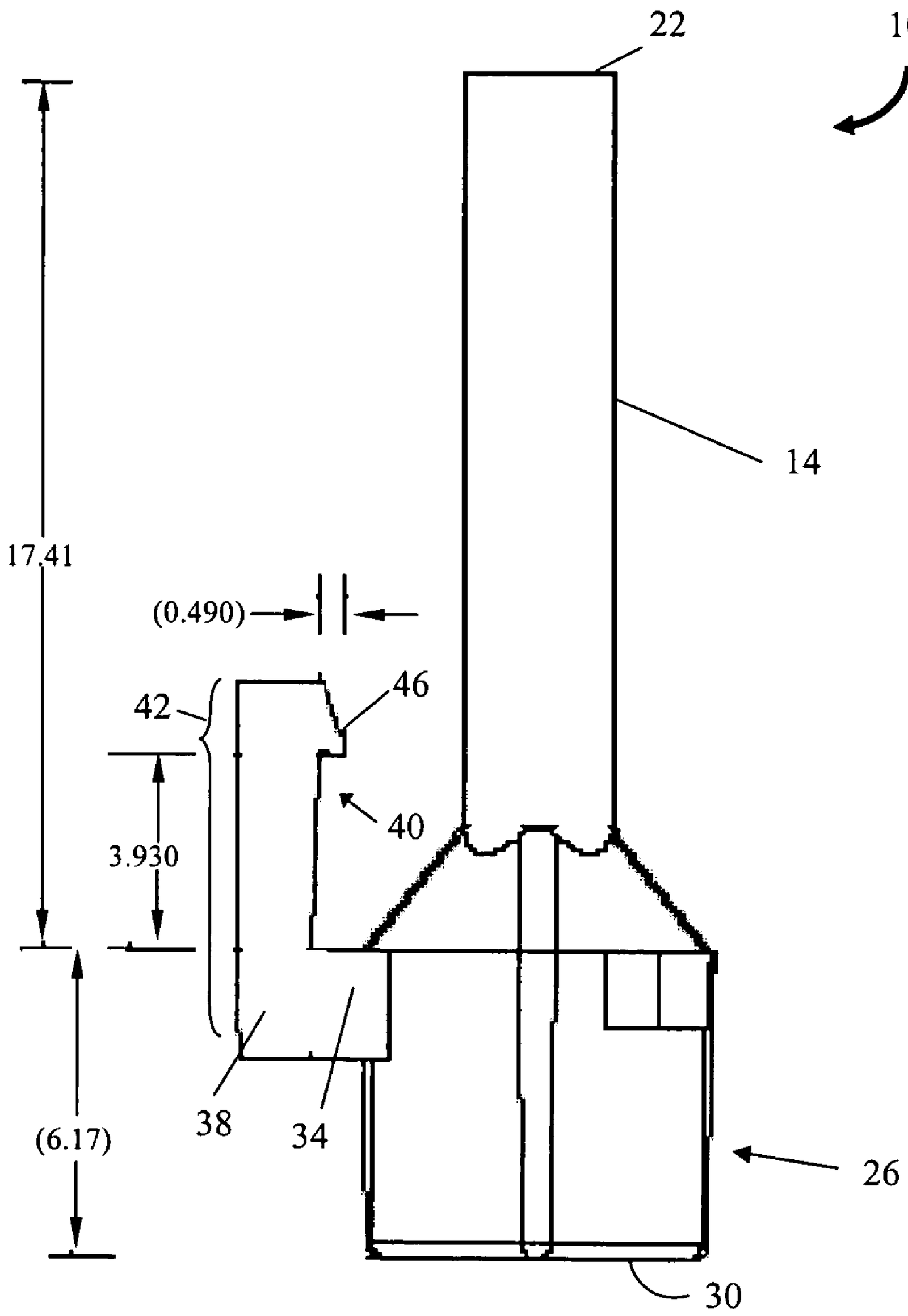


FIG. 2

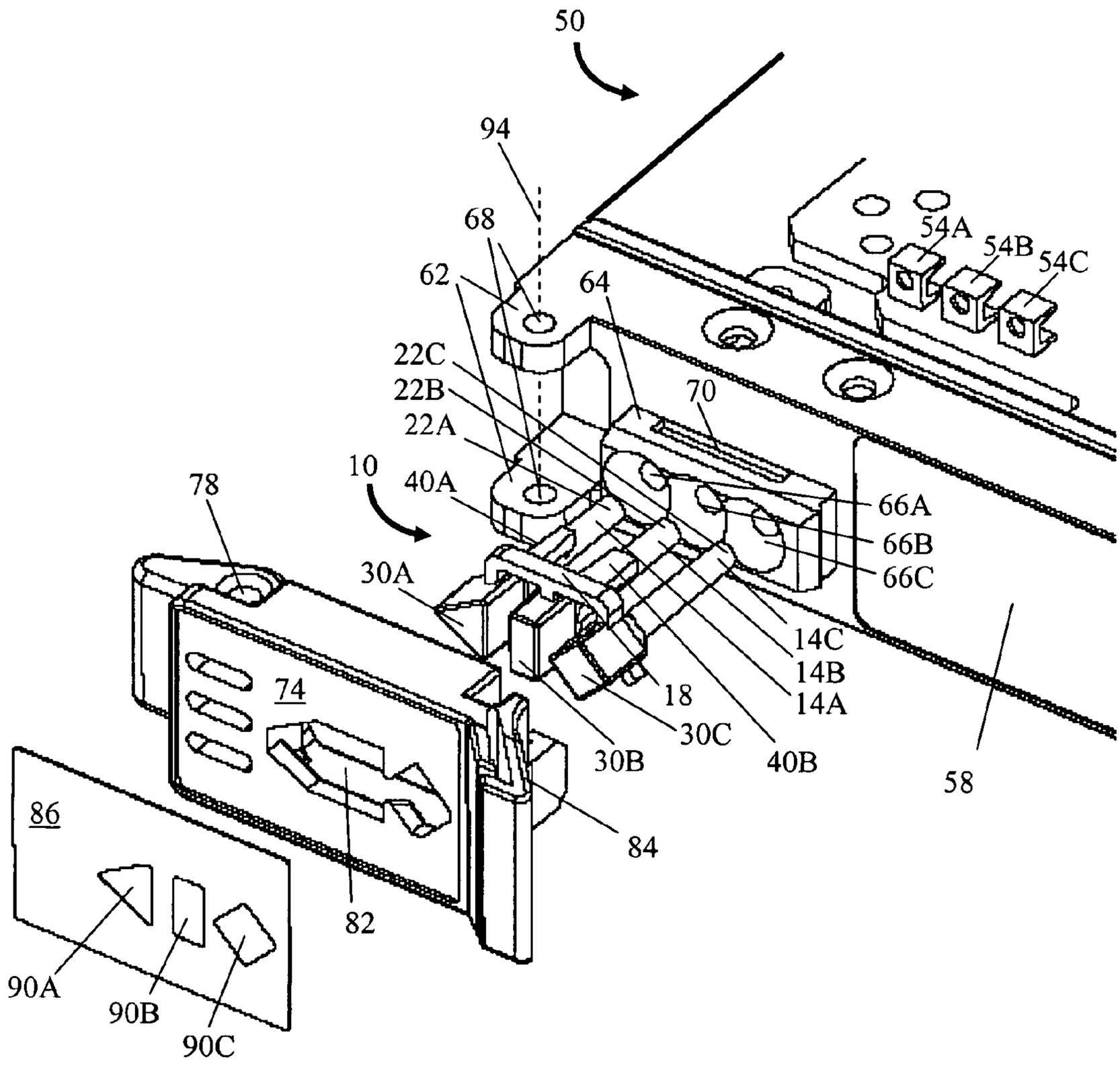

50
94
68
62
64
54A
54B
54C
22C
22B
22A
70
10
40A
78
66A
66B
66C
30A
14C
14B
14A
18
74
30C
30B
40B
58
86
84
82
90A
90B
90C

FIG. 3

DEVICE FOR CONDUCTING SOURCE LIGHT THROUGH AN ELECTROMAGNETIC COMPLIANT FACEPLATE

FIELD OF THE INVENTION

The invention relates generally to electromagnetic compliant enclosures. More particularly, the invention relates to light pipe devices for conducting light through electromagnetic compliant faceplates.

BACKGROUND

Light emitting diodes (LEDs) are often used to indicate the operational status of circuitry. LEDs are generally small and often mounted on circuit boards or electronic modules within an electromagnetic compliant (EMC) enclosure. In some applications, an EMC faceplate shields the LEDs from sight. However, EMC faceplates can have bores, or openings, that have diameters less than predetermined values without affecting the EMC properties of the enclosure.

Light pipes are sometimes used to transfer the light emitted by the LEDS to a viewable surface that is external to the EMC enclosure. The light pipes pass through the bores of the faceplate. As such, the diameter of the light pipe is constrained by the predetermined maximum bore diameter that does not degrade the EMC properties. This diameter can be a few millimeters or less, depending on the specific EMC requirements and the enclosed circuitry. As such, the viewing surface outside the enclosure typically does not exceed a few millimeters and is therefore difficult to see. Often light from one light pipe couples, or "bleeds", into one or more neighboring light pipes through the structure used to fix the light pipes to each other. Thus, if only one LED is on, neighboring light pipes can also receive some of the light emitted from the active LED at their respective endfaces, thereby making it difficult to determine the status of the circuitry. Additionally, if the LEDs generate different color light, the light from LEDs of neighboring light pipes can reduce the visibility at the endface of a given light pipe.

What is needed is a device for conducting light through an electromagnetic compliant faceplate that is not limited in size by EMC requirements and reduces the bleeding of light into neighboring light pipes. The present invention satisfies this need and provides additional advantages.

SUMMARY OF THE INVENTION

In one aspect, the invention is directed to a device for conducting light through an electromagnetic compliant faceplate. The device includes a first light pipe, a second light pipe and a connector. The first and second light pipes each has a first end to receive light from a respective light source and a second end with an expanded endface. The connector has an elongated portion, a first attachment portion and a second attachment portion. The first and second attachment portions extend from the elongated portion and are coupled to the first and second light pipes, respectively. In one embodiment, the first and second light pipes and the connector are fabricated as an integral unit. In another embodiment, the first and second light pipes are fabricated from a clear plastic material. In yet another embodiment, the first and second attachment portions attach to the first and second light pipes at a first point and a second point, respectively. The elongated portion is substantially parallel to a line defined between the first and second points.

In another aspect, the device includes a first light pipe, a second light pipe, and a connector. The first and second light pipes each has a first end to receive light from a respective light source and a second end with an expanded endface. The connector is attached to the first and second light pipes. The connector has at least one tab, an elongated portion, a first attachment portion and a second attachment portion. The first and second attachment portions extend from the elongated portion and are coupled to the first and second light pipes, respectively. In one embodiment, each of the first and second light pipes extend through a respective opening in the faceplate. In another embodiment, the device also includes the light sources. In a further embodiment, the light sources are light emitting diodes. In yet another embodiment, the tab or tabs of the connector include a resilient stem having a first end attached to the connector and a second end to be received by a channel in the electromagnetic compliant faceplate.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and further advantages of this invention may be better understood by referring to the following description in conjunction with the accompanying drawings, in which like numerals indicate like structural elements and features in various figures. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention.

FIGS. **1**A and **1**B are isometric views of a device for conducting light through an electromagnetic compliant faceplate according to an embodiment of the present invention;

FIG. **1**C is an end view of the device of FIGS. **1**A and **1**B;

FIG. **2** is a side view of the device of FIGS. **1**A and **1**B showing exemplary dimensions; and

FIG. **3** is an exploded view of the device of FIGS. **1**A and **1**B mounted to an electromagnetic compliant faceplate.

DETAILED DESCRIPTION

With reference to FIGS. **1**A, **1**B, and **1**C, in one embodiment the invention is directed to a device **10** for conducting light through an electromagnetic compliant (EMC) faceplate. The device includes a first light pipe **14**A, a second light pipe **14**B, and a third light pipe **14**C (referred to generally as light pipes **14**) attached to a connector **18**. The light pipes **14** each have a first end **22**A, **22**B, **22**C (referred to generally as first ends **22**) and a second end **26**A, **26**B, **26**C (referred to generally as second ends **26**). Each of the second ends **26** has an expanded endface **30**A, **30**B, **30**C, respectively (referred to generally as endface **30**). The light pipes **14** have circular cross-sections with cross-sectional areas less than the areas of their respective expanded endfaces **30**. The light pipes **14** are adapted to conduct (i.e., transmit within the light pipe) light incident on their first ends **22** from respective light sources. The light sources can be, for example, light emitting diodes (LEDs) or laser diodes.

The diameter of the first ends **22** is approximately the same as the diameter of the respective light pipes **14**. The expanded endfaces **30** of the second ends **26** have a shape (e.g., polygonal) and are substantially larger than the diameter of the light pipes **14** to facilitate viewing. In some applications each endface **30** has a particular shape that is associated with one of the different modes or possible status conditions of the enclosed circuitry. For example, the endface **30**A of one light pipe **14** is triangular, the endface **30**B

of the second light pipe **14** is rectangular, and the endface **30**C of the third light pipe **14** is square.

The connector **18** includes attachment portions **34**A, **34**B, and **34**C (referred to generally as attachment portions **34**, only **34**C is visible due to perspective views) and an elongated portion **38**. The attachment portions **34** extend from near the second ends **26** of the light pipes **14** at respective attachment points. The elongated portion **38** attaches to each of the respective attachment portions **34**, such that the elongated portion **38** is substantially parallel to a line defined by the attachment points of the attachments portions **34**.

The connector **18** maintains the alignment of the light pipes **14** with respect to each other and to respective openings for the light pipes **14** in the EMC faceplate. For example, the light pipes **14** can be in substantially planar alignment. In the illustrated embodiment, the light pipes **14** are also parallel to each other. The attachment portions **34** extend from the light pipes **14** in a direction substantially orthogonal to the axes of the light pipes **14**. The elongated portion **38** lies in a plane that is substantially parallel to the plane of the light pipes **14** and extends in a direction substantially orthogonal to the axes of the light pipes **14** and substantially orthogonal to the attachment portions **34**. Because the connector **18** is "out-of-plane" with the light pipes **14**, there is no direct optical path established between the light pipes **14** by the connector **18**. Thus the bleeding of light from one light pipe **14** into another light pipe **14** is substantially reduced over conventional light pipe devices having direct coupling of the light pipes.

In the illustrated embodiment, the connector **18** includes tabs **40**A, **40**B (referred to generally as tabs **40**). The tabs **40** include resilient stem portions **42**A, **42**B attached at one end to the elongated portion **38** of the connector **18**. Each tab includes a second end **46**A, **46**B shaped to be received in a channel in the faceplate. For example, the second ends **46** can be barb-shaped, although other shapes are possible.

In the illustrated embodiment, the device **10** is constructed as an integral unit and has exemplary dimensions as shown in FIG. **2**. For example the device **10** is constructed using an injection molding technique, although other techniques can be used as well such as machining from a block of material. The device **10** is constructed out of a clear plastic material such as optically clear polycarbonate although other materials such as glass are possible. As stated above, the device is designed to conduct light from a light source to a viewable expanded endface **30**, therefore any material that can transmit light from the light source to the endface **30** can be used.

With reference to FIG. **3**, the device **10** is used to indicate the status of circuitry contained within an EMC enclosure **50**. The enclosure **50** contains a first light source **54**A, a second light source **54**B, and a third light source **54**C (referred to generally as light sources **54**). The light sources **54** are LEDs, although other light sources are possible. In one embodiment, each LED is a different color and is used to indicate a different operational status of the circuitry. For example, the first light source **54**A is a red LED and used to indicate that the circuitry is not functioning properly, the second light source **54**B is a green LED and used to indicate that the circuitry is functioning normally, and the third light source **54**C is a blue LED and used to indicate that the circuitry is performing a specified operation (e.g., transmitting data).

The enclosure **50** includes an EMC complaint faceplate **58** and pivot tabs **62**. The faceplate **58** is attached to or is otherwise integrated with the enclosure **50**. The faceplate **58** includes a mounting frame **64**, a first bore **66**A, a second bore **66**B, a third bore **66**C (referred to generally as bores **66**), and a channel **70** for receiving the barbed-shaped ends **46** of the device tabs **40**. In one embodiment, the bores **66** have a diameter of 3 millimeters and length of 12 millimeters. In other words, the faceplate **58** has a 12 mm thickness and the bores **66** have an aspect ratio of 4:1. In other embodiments, other aspect ratios are used to satisfy EMC requirements of various designs.

The pivot tabs **62** include holes **68** to receive a pin that attaches a latch panel **74** to the enclosure **50**. The latch panel **74** includes a bore **78** to receive the pin, an opening **82** shaped to pass the expanded endfaces **30** of the device **10**, and a latch **84** to secure the latch panel to the faceplate **58**. A label **86** having textured translucent portions is attached to the latch panel **74** to identify the circuit status corresponding to each endface **30**. The label **86** includes a first opening **90**A, a second opening **90**B, and a third opening **90**C (referred to generally as openings **90**) to accommodate the respective endfaces **30** of the device **10**.

The device **10** is installed to the faceplate **58** by inserting the light pipes **14** through the respective bores **66** of the faceplate **58**. The channel **70** receives the barb-shaped ends **46** of the tabs **40** to secure the device **10** to the mounting frame **64** so that the first ends **22** of the light pipes **14** are maintained close to their respective light sources **54**. The latch panel **74** rotates about an axis **94** defined by the holes **68** in the pivot tabs **62** and engages the faceplate **58** so that each endface **30** extends through the opening **82** in the latch panel **74** and a respective opening **90** in the label **86**.

During operation of the enclosed circuitry, light from a light source **54** is conducted to the respective endface **30** of the device **10**. For example, the enclosure **50** can include sources of different color light, such as green, red and blue. In this example, if the circuitry is operating correctly, the second light source **54**B emits green light. The second light pipe **14**B conducts the green light to its endface **30**B. Because the connector **18** is out of plane with respect to the light pipes **14**, any green light exiting the light pipe **14**B through the attachment portion **34**B encounters multiple bends in the light path before reaching any of the other light pipes **14**A, **14**C. Consequently, the green light intensity at the endfaces **30**A, **30**C of the neighboring light pipes **14**A, **14**C is substantially reduced in comparison to a conventional light pipe device having a direct connection between its light pipes.

While the invention has been shown and described with reference to specific preferred embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the following claims. For example, the device **10** can include a connector **18** with an elongated portion **38** that is curved and can be non-planar. In another example, the attachment portions **34** of the connector **18** are not orthogonal to the axes of the light pipes **14** or the elongated portion **38**. Instead, the attachment portions **34** include curves, or bends, where they join the light pipes **14** and/or the elongated portion **38**, thereby providing an indirect light path between the light pipes **14**.

What is claimed is:

1. A device for conducting light through an electromagnetic compliant faceplate comprising:

a first light pipe having a first end to receive light from a first light source and a second end with an expanded endface;

a second light pipe having a first end to receive light from a second light source and a second end with an expanded endface; and

a connector having an elongated portion, a first attachment portion and a second attachment portion, the first and second attachment portions extending substantially orthogonal from the elongated portion, the first attachment portion extending substantially orthogonal from the first light pipe and the second attachment portion extending substantially orthogonal from the second light pipe, wherein a path defined between the first and second light pipes through the connector conducts substantially no light due to a plurality of bends therein.

2. The device of claim **1** wherein the first and second light pipes and the connector are fabricated as an integral unit.

3. The device of claim **1** wherein the first and second attachment portions attach to the first and second light pipes at a first point and a second point, respectively, the elongated portion being substantially parallel to a line defined between the first and second points.

4. The device of claim **1** wherein the first and second light pipes are in parallel alignment.

5. The device of claim **1** wherein the device is fabricated from a clear plastic material.

6. A device for conducting light through an electromagnetic compliant faceplate comprising:

a first light pipe having a first end to receive light from a first light source and a second end with an expanded endface;

a second light pipe having a first end to receive light from a second light source and a second end with an expanded endface; and

a connector attached to the first and second light pipes and having at least one tab, an elongated portion, a first attachment portion and a second attachment portion, the first and second attachment portions extending substantially orthogonal from the elongated portion, the first attachment portion extending substantially orthogonal from the first light pipe and the second attachment portion extending substantially orthogonal from the second light pipe, wherein a path defined between the first and second light pipes through the connector conducts substantially no light due to a plurality of bends therein.

7. The device of claim **6** wherein the first and second light pipes and the connector are fabricated as an integral unit.

8. The device of claim **6** further comprising the faceplate, each of the first and second light pipes extends through a respective opening in the faceplate.

9. The device of claim **6** further comprising the first and second light sources.

10. The device of claim **9** wherein the first and second light sources are light emitting diodes.

11. The device of claim **6** wherein the tab of the connector comprises a resilient stem having a first end attached to the connector and a second end to be received by a channel in the electromagnetic compliant faceplate.

12. The device of claim **6** wherein the device is fabricated from a clear plastic material.

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